

CUP+

Consumptive Use Program Plus
An Application for Agricultural Water Demand Planning

A user-friendly Microsoft® Excel application program, “Consumptive Use Program Plus,” or **CUP Plus**, was developed to help growers and water agencies determine reference evapotranspiration (**ET_o**), crop coefficient (**K_c**) values, crop evapotranspiration (**ET_c**), and evapotranspiration of applied water (**ET_{aw}**). **ET_{aw}** is an estimate of the seasonal irrigation requirement that assumes minimal water stress and 100-percent application efficiency. **CUP Plus** also can project the impact of climate change on **ET_c** and **ET_{aw}**.



Division of Statewide Integrated Water Management
Department of Water Resources
Natural Resources Agency

www.water.ca.gov

For detailed information and publications:
www.water.ca.gov/landwateruse/models.cfm

Contact: Morteza.Orang@water.ca.gov





Crop evapotranspiration is estimated as $ET_c = ET_o \times K_c$, where K_c is a crop coefficient used to adjust for the difference between ET_o and ET_c .

Reference evapotranspiration (ET_o) is an estimate of the evapotranspiration of a virtual vegetated surface with fixed canopy resistance and aerodynamic resistance estimated as an inverse function of wind speed. The ET_o is approximately equal to the ET_c from a 12-centimeter-tall cool-season grass that is not lacking for water.

CUP Plus computes ET_o from daily solar radiation, maximum and minimum temperature, dew-point temperature, and wind speed by using the daily standardized reference evapotranspiration equation recommended by the American Society of Civil Engineers.

When only maximum and minimum temperature data are available, the Hargreaves and Samani (1985) equation is used to calculate ET_o . When daily weather data are unavailable, **CUP Plus** uses a smooth-curve-fitting technique to derive one year of daily weather data from the monthly data to estimate daily ET_o .

Daily rainfall and ET_o rate data are used to estimate bare soil evaporation, and the bare soil K_c values are used to estimate the off-season evapotranspiration and to provide a baseline for in-season K_c calculations.

For tree and vine crops, **CUP Plus** accounts for cover crop and immaturity effects on K_c values.

The generated ET_o and K_c values are used to determine daily ET_c values which, in turn, are used with precipitation data, soil characteristics, and crop information to generate hypothetical water-balance irrigation schedules and to determine ET_{aw} .

The **CUP Plus** application can use either input or generated daily climate data.

Finally, the application outputs a wide range of tables and charts that are useful for irrigation planning.